Monitor of Beam in the Abort Gap

a.k.a. Abort Gap Integrator (AGI)

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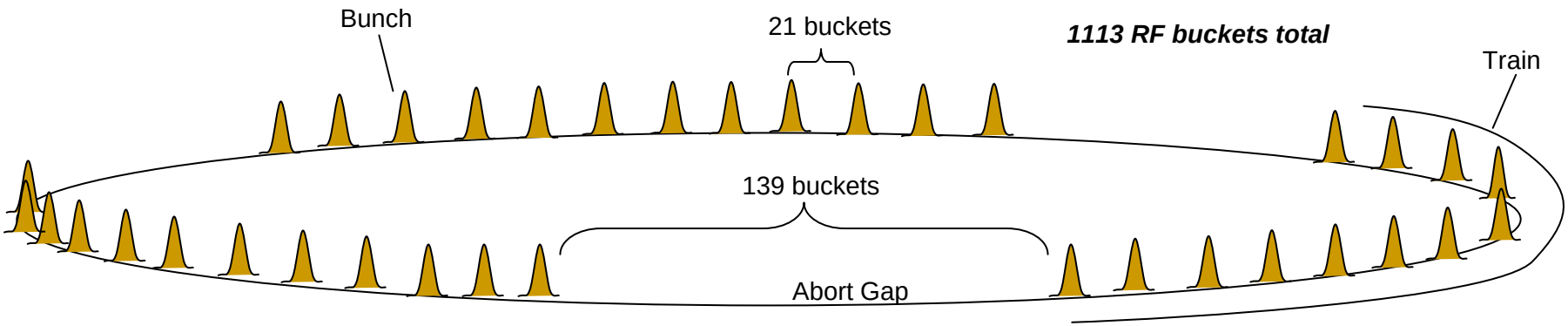
DOE Review of Tevatron Operations at FNAL

March 29-31, 2005

AGI – TeV Bunch Structure

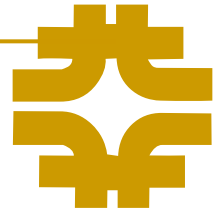


- The Tevatron operates with 36 bunches in 3 groups called trains
- Between each train there is an abort gap that is 139 RF buckets long
  - RF bucket is 18.8 ns → Abort gap is 2.6 μs

AGI - Motivation

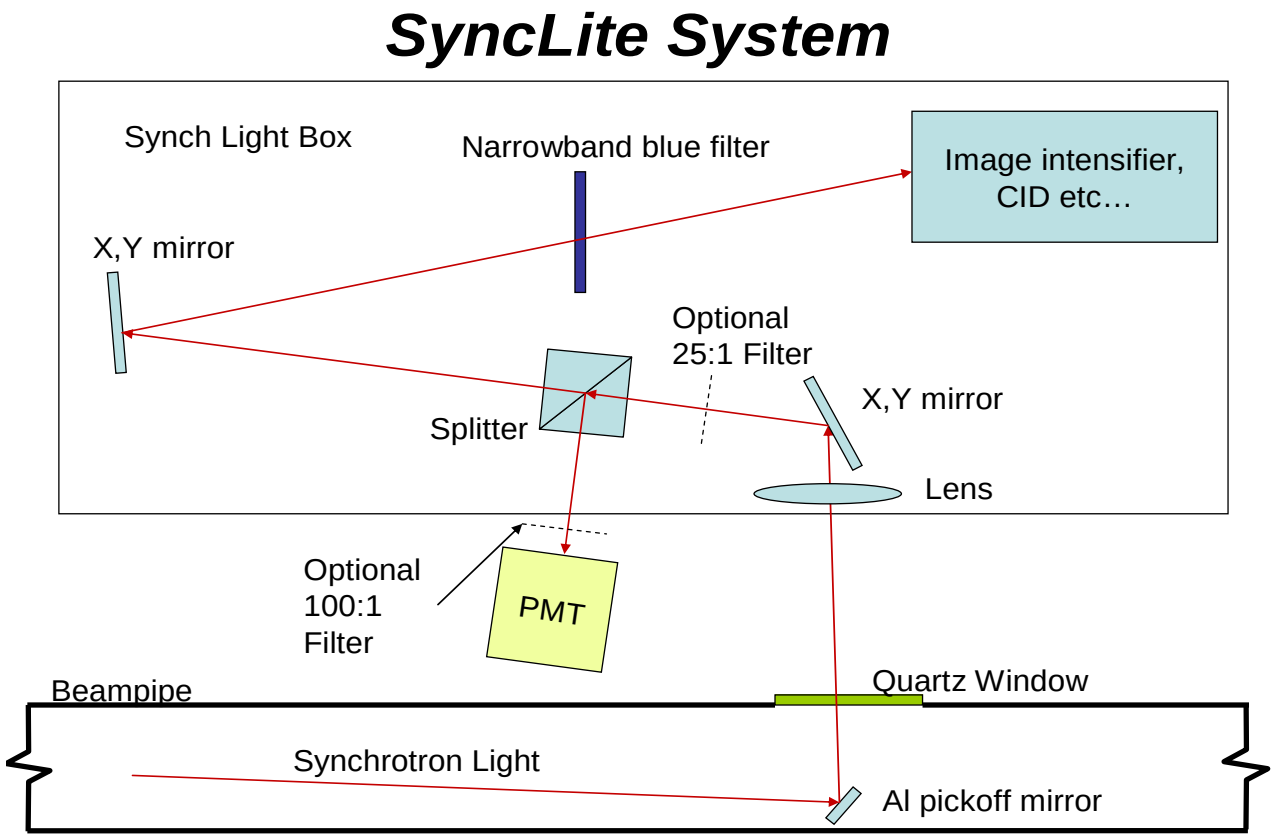
- During an abort
  - Abort kicker magnet ramps up during abort gap
  - Beam in the abort gap is directed towards magnets, CDF, etc…
    - Quenches (in the past, 10 x 10^9 caused quenches)
    - CDF silicon detector damage
- Previous monitors relied on counters external to the beampipe that were timed with abort gap
  - Measured stuff leaving the abort gap, not stuff still in it
- Use synchrotron radiation to directly measure abort gap beam
  - Want to be sensitive to a DC beam that is 1 part in 10^4 of the total beam

AGI - Apparatus

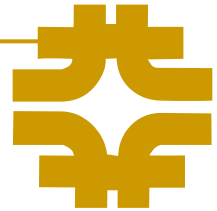


- Made use of existing synchrotron light system
  - Measures beam profile
- Added beam splitter and gated photomultiplier tube
  - Photomultiplier had to be gateable and insensitive to light present just before the gate (bunch intensity is several thousand times brighter than DC beam)
    - Custom gating circuit for generic photomultiplier
      - Pulse two dynodes
    - Hamamatsu gated MCP style PMT on loan from LBNL

AGI - Apparatus



AGI – Data Acquisition



- PMT signal is integrated and digitized using locally built integrator and commercial VME ADC
- Readout is through a VxWorks front end which also controls the timing of the PMT and integrator gates
- Average 1000 samples in each of the 3 abort gaps

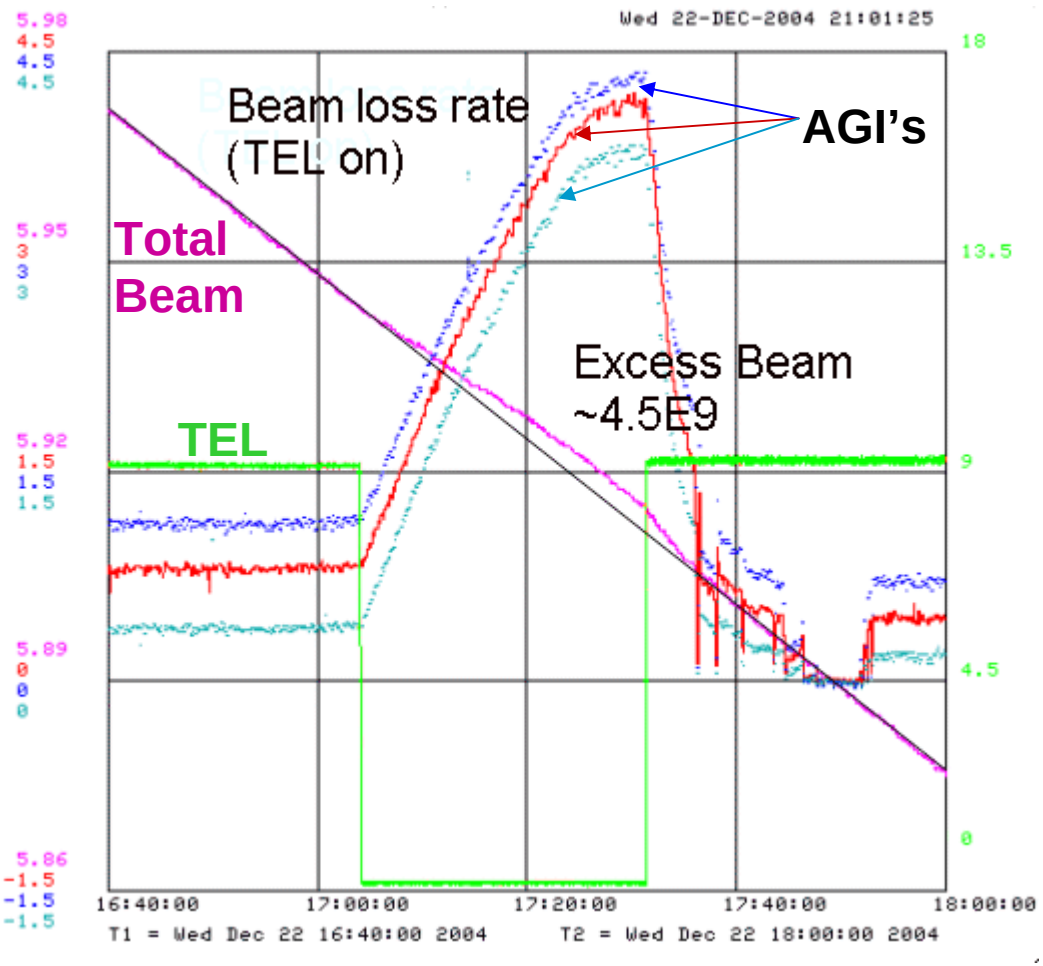
AGI – Commissioning

- Installed ~June 2004
  - LBNL gated MCP-PMT installed ~July 2004 and in use since then
- Calibrations
  - Bunch based (using an optical attenuator)
  - TeV Electron Lens (TEL) based
    - TEL normally cleans the abort gaps
    - Turn TEL off and compare growth of abort gap beam with total beam from DCCT measurement
- Looked at abort gap structure using photon counting

AGI – TEL Study

December 2004

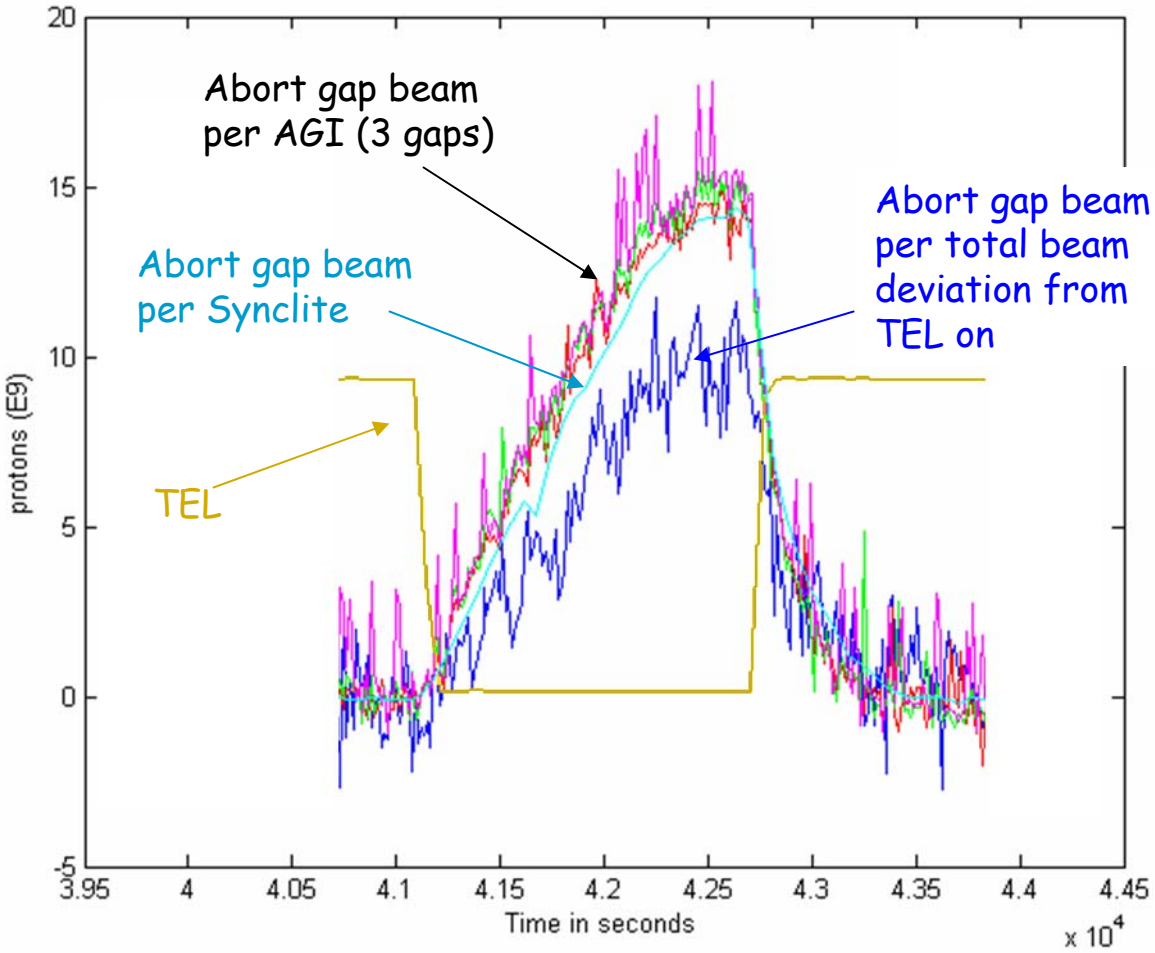
- When TEL is turned off, DC beam stops being ejected and accumulates around the ring including the abort gap
  - The beam loss rate decreases
- Determine excess beam by measuring deviation of total beam from projected value with TEL on



AGI – TEL Study

June 2004

Projected total beam from TEL on subtracted from total beam

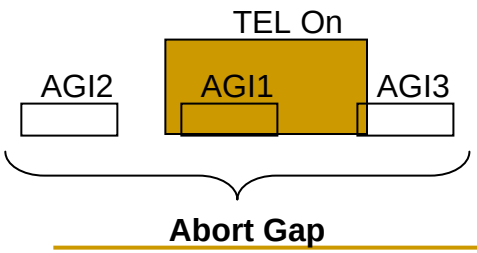


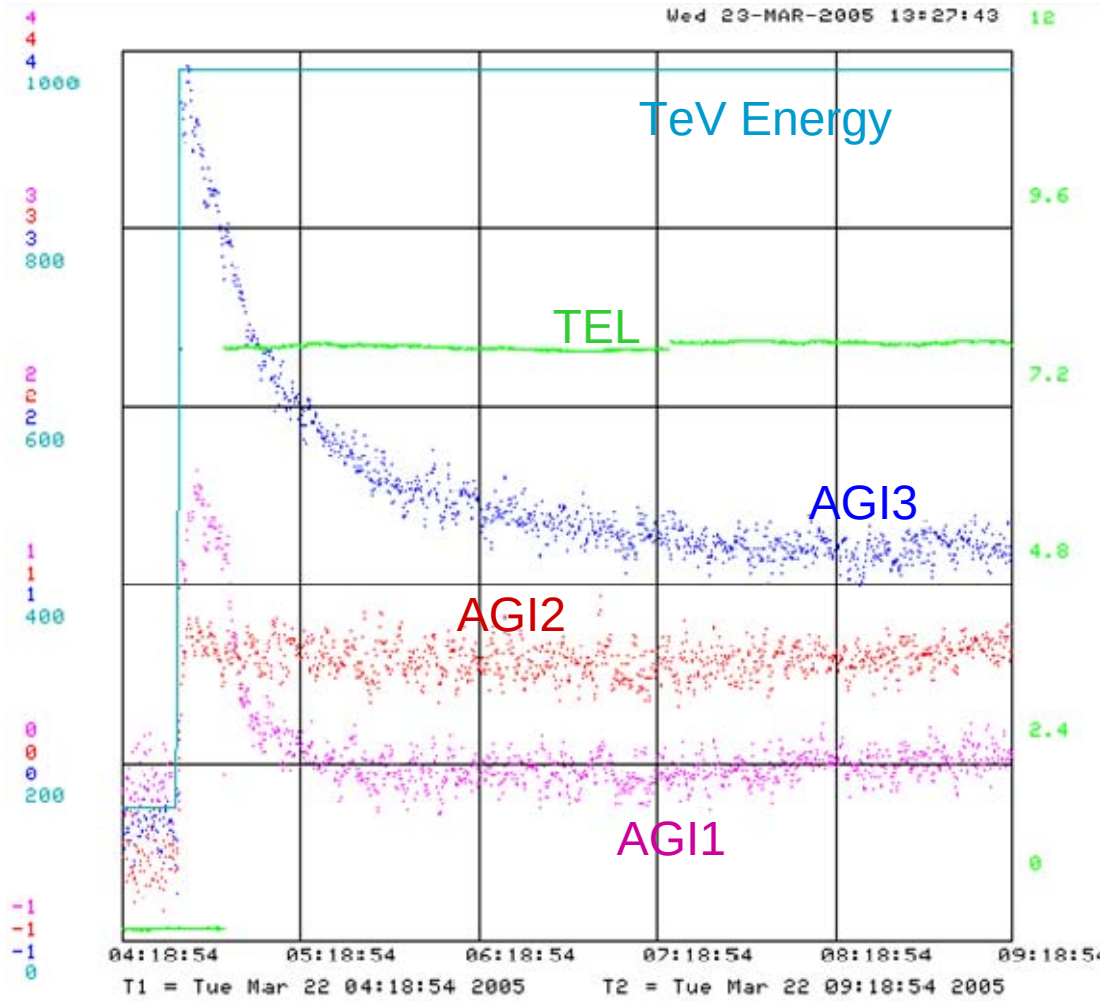
AGI - Status

Beginning of store
March 2005

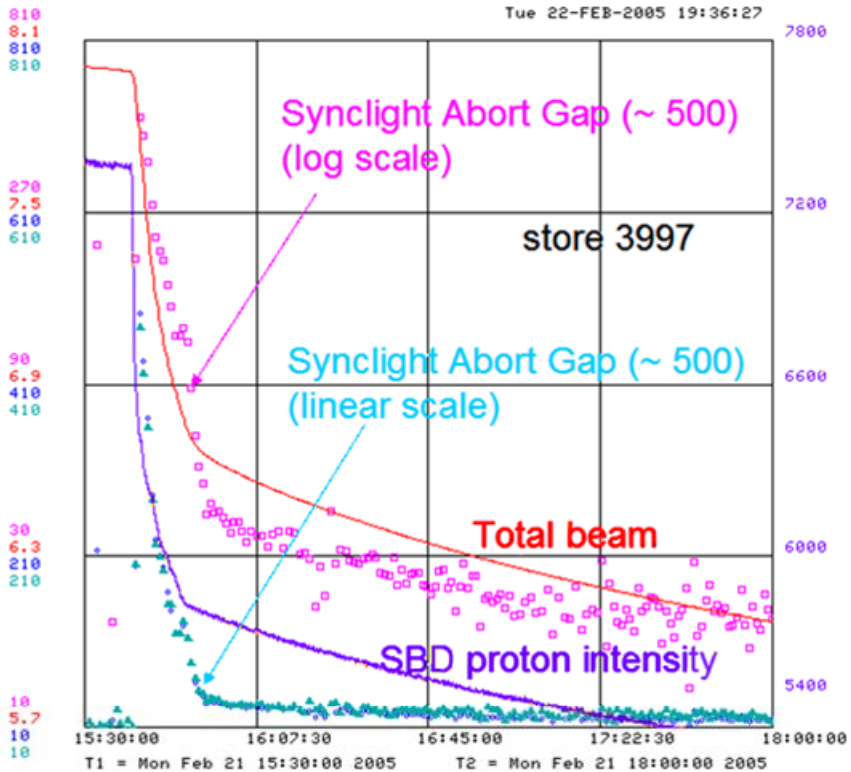
AGI1, AGI2, and AGI3 are measurements of the abort gap beam at three different positions within the abort gap

Their behavior depends on their position relative to the action of the TEL



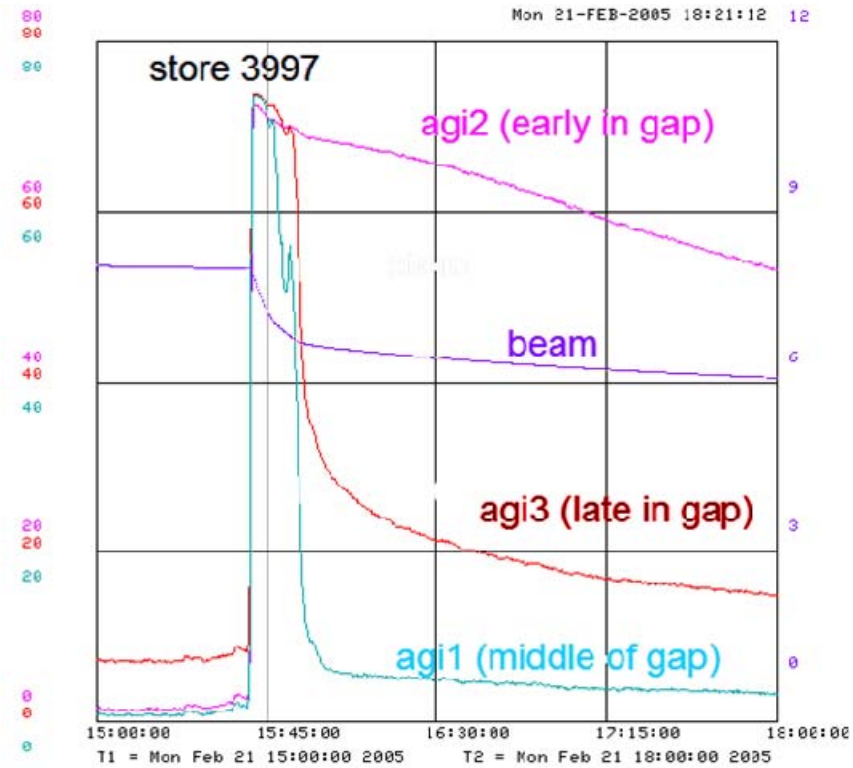


AGI – Status



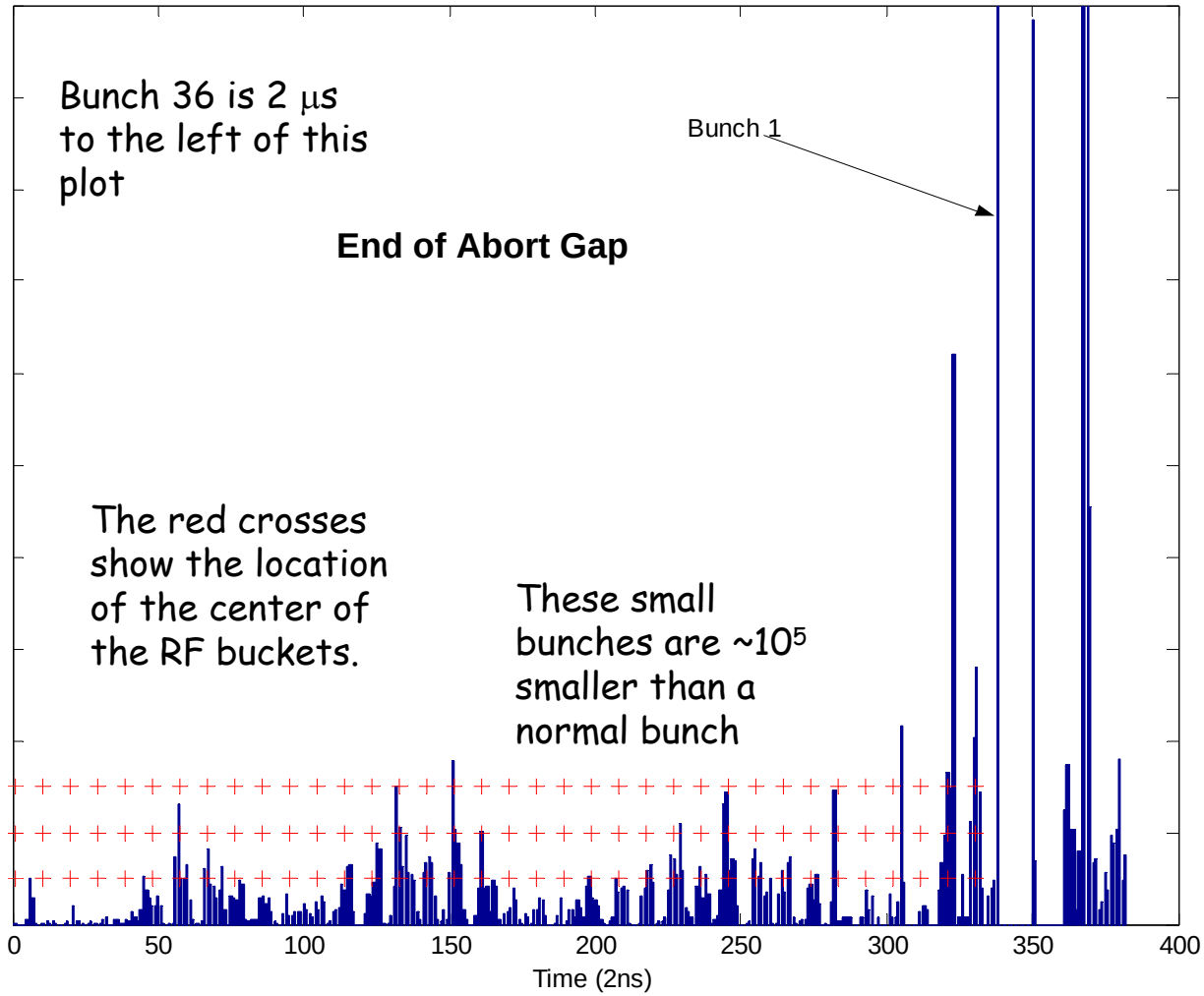
Feb 21, 2005

- Longitudinal Damper problem
- Caused beam to be shaken out of the bunches

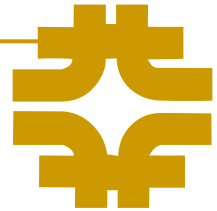


AGI – Longitudinal Structure

These data were collected using a PMT pulse-over-threshold counting technique



AGI – Conclusion



- Integral part of TeV operations
  - Checked by the sequencer before normal beam aborts
  - Watched by CDF and MCR
    - i.e. I get paged when it hiccups
- Next Steps
  - Measure pbars in abort gaps (TeV request)
  - Consider separating the abort gap monitor from the normal synchrotron light system